1. A voltage regulator having an input terminal to be coupled to an input voltage source and an output terminal to be coupled to a load, comprising:

a switching circuit to intermittently couple the input terminal and the output terminal in response to a digital control signal;

a filter to provide a generally DC output voltage at the output terminal;

a current sensor to generate a digital first feedback signal representing the current passing through the switching circuit;

a voltage sensor to generate a second feedback signal representing the output voltage; and a digital controller which receives and uses the digital feedback signal to generate the digital control signal, the digital controller configured to maintain the output voltage at the output terminal at a substantially constant level.

- 2. The voltage regulator of claim 1, wherein the switching circuit includes a rectifier to at least intermittently couple the output terminal to ground.
 - 3. The voltage regulator of claim 1, wherein the switching circuit, filter and current sensor are fabricated on a first IC chip, and the digital controller is fabricated on a second, separate IC chip.

20

30

5

10

- 4. The voltage regulator of claim 1, wherein the digital feedback signal indicates whether the current exceeds a threshold current.
- 5. The voltage regulator of claim 4, wherein the current sensor generates a plurality digital feedback signals, each signal representing whether the current has exceeded a different threshold current.
 - 6. The voltage regulator of claim 4, wherein the current sensor generates a plurality digital feedback signals, each signal representing whether the current has crossed a different threshold current.

7. The voltage regulator of claim 4, further comprising a fault protection circuit to override the digital control signal and open the switching circuit if the current passing through the switching circuit exceeds a safety limit, the safety limit being larger than the threshold current.

5

- 8. The voltage regulator of claim 7, wherein the fault protection circuit generates a second digital feedback signal which is received by the digital controller if the current exceeds the safety limit.
- 10 9. The voltage regulator of claim 4, wherein the switching circuit includes a first transistor to couple the output terminal to the input terminal and a second transistor to couple the output terminal to ground.
- 10. The voltage regulator of claim 9, wherein the current sensor includes a first sensor to
 generate a first digital feedback signal on a first feedback line indicating the current passing
 through the first transistor and a second sensor to generate a second digital feedback signal on a
 second line representing the current passing through the second transistor.
- 11. The voltage regulator of claim 10, wherein the first and second feedback lines are coupled to a third feedback line which is coupled to the digital controller, and the digital controller includes logic to determine which transistor is represented by the signal on the third feedback line.
- 12. The voltage regulator of claim 9, further comprising an interpreter located on the slave
 which receives the digital control signal and converts the digital control signal into a command to switch the first and second transistors.
 - 13. The voltage regulator of claim 12, wherein the digital control signal generated by the digital controller includes a first control signal on a first control line and a second control signal on a second line, and the interpreter converts the first control signal into a command to open the

first transistor and close the second transistor and converts the second control signal into a second command to close the first transistor and open the second transistor.

14. The voltage regulator of claim 13, wherein the digital control signal generated by the digital controller includes a third control signal on a third control line, and the interpreter converts the third control signal into a command to open the first and second transistors.

5

10

15

25

- 15. The voltage regulator of claim 14, wherein the interpreter converts the third control signal into a command to open the first and second transistors if the second transistor is closed and the current falls below zero.
 - 16. The voltage regulator of claim 1, further comprising a state sensor to generate a digital state signal indicating the state of the switching regulator which is received by the digital controller.
 - 17. The voltage regulator of claim 1, wherein the slave includes an interpreter which receives the digital control signal and converts the digital control signal into a command to switch the switching circuit.
- 20 18. A voltage regulator having an input terminal to be coupled to an input voltage source and an output terminal to be coupled to a load, comprising:
 - a) a plurality of slaves, each slave including
 - i) a switching circuit to intermittently couple the input terminal and the output terminal in response to a digital control signal,
 - ii) a filter to provide a generally DC output voltage at the output terminal;
 - iii) a current sensor to generate a digital feedback signal representing the current passing through the switching circuit; and
 - b) a digital controller which receives and uses the digital feedback signals from the slave plurality of slaves to generate a plurality of digital control signals, the digital controller configured to maintain the output voltage at the output terminal at a substantially constant level.

19. A method of operating a voltage regulator having an input terminal to be coupled to an input voltage source and an output terminal to be coupled to a load, comprising:

intermittently coupling the input terminal and the output terminal with a switching circuit in response to a digital control signal;

filtering an output of the switching circuit to provide a generally DC output voltage at the output terminal;

generating a digital feedback signal representing the current passing through the switching circuit with a current sensor; and

receiving and using the digital feedback signal from the slave in a digital controller to generate the digital control signal, the digital controller configured to maintain the output voltage at the output terminal at a substantially constant level.

20. A voltage regulator having an input terminal to be coupled to an input voltage source and an output terminal to be coupled to a load, comprising:

a switching circuit to intermittently couple the input terminal and the output terminal in response to a control signal;

a filter to provide a generally DC output voltage at the output terminal; and

a digital controller which operates at a clock frequency f_{clock} which is significantly faster than a desired switching frequency f_{switch} of the switching circuit, wherein each clock cycle the digital controller receiving a first digital feedback signal derived from an output voltage at the output terminal and a second digital feedback signal derived from a current passing through the switching circuit, and generates the control signal to control the switching circuit so that the output voltage is maintained at a substantially constant level.

25

30

5

10

15

- 21. The voltage regulator of claim 20, further comprising a current sensor to generate the first digital feedback signal.
- 22. The voltage regulator of claim 21, further comprising a voltage sensor to generate the second digital feedback signal.

- 23. The voltage regulator of claim 22, wherein the voltage sensor includes an analog-to-digital converter.
- 5 24. The voltage regulator of claim 23, wherein the voltage sensor further includes a voltage sampler.
 - 25. The voltage regulator of claim 22, wherein the switching circuit, filter and current sensor are fabricated on a first IC chip and the digital controller and voltage sensor are fabricated on a second, different IC chip.
 - 26. The voltage regulator of claim 22, wherein the switching circuit, filter and current sensor are fabricated on a first IC chip, the voltage sensor is fabricated on a second IC chip, and the digital controller is fabricated on a third IC chip.
 - 27. The voltage regulator of claim 20, wherein the first digital feedback signal represents the difference between the output voltage and a nominal voltage.
 - 28. The voltage regulator of claim 20, wherein the first digital feedback signal represents the difference between the output voltage in a current clock cycle and an output voltage in a previous clock cycle.
 - 29. The voltage regulator of claim 20, wherein each clock cycle the digital controller receives a third digital feedback signal derived from an output voltage at the output terminal.
 - 30. The voltage regulator of claim 29, wherein the first digital feedback signal is equal to the difference between the output voltage and a nominal voltage, and the third digital feedback signal is equal to the difference between the output voltage in a current clock cycle and an output voltage in a previous clock cycle.

25

10

- 31. The voltage regulator of claim 20, wherein the first digital feedback signal is the output voltage.
- 32. The voltage regulator of claim 20, wherein digital controller is coupled to the output terminal, and the controller includes a sampling circuit to capture a difference between the output voltage and a reference voltage, the digital controller further including an analog-to-digital converter to convert the charge held by the sampling circuit into a digital signal.
 - 33. The voltage regulator of claim 32, wherein the reference voltage is ground.

10

15

20

30

- 34. The voltage regulator of claim 32, wherein the reference voltage is a nominal voltage.
- 35. The voltage regulator of claim 32, wherein the reference voltage is an output voltage from a previous clock cycle.
- 36. The voltage regulator of claim 20, further comprising a plurality of switching circuits to intermittently couple the input terminal and the output terminal, wherein each clock cycle the digital controller receives a second digital feedback signal for each switching circuit and generates a control signal for that switching circuit, each second digital feedback signal derived from a current passing through an associated switching circuit.
- 37. A method of operating a voltage regulator having an input terminal to be coupled to an input voltage source and an output terminal to be coupled to a load, comprising:

intermittently coupling the input terminal and the output terminal with a switching circuit
in response to a control signal

filtering an output of the switching circuit to provide a generally DC output voltage at the output terminal; and

operating a digital controller at a clock frequency f_{clock} which is significantly faster than a desired switching frequency f_{switch} of the switching circuit;

receiving a first digital feedback signal derived from an output voltage at the output

terminal in the digital controller each clock cycle;

receiving a second digital feedback signal derived from a current passing through the switching circuit in the digital controller each clock cycle; and

generating the control signal with the digital controller to control the switching circuit so that the output voltage is maintained at a substantially constant level. 5